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ABSTRACT

This report contains the findings of a national survey on the information technology (IT) workforce. Findings are based on responses to a telephone survey of a single representative from 532 companies, both IT and non-IT, with more than 100 employees. The report is divided into three major sections: survey goals and process, results, and a conclusion. Six results are discussed in detail: (1) reported IT positions and vacancies; (2) education requirements for core IT positions; (3) retention and hiring of core IT positions; (4) strategies for meeting IT personnel needs; (5) training challenges; and (6) training providers. Seven tables show results. Appendices include a background on IT workforce issues; core occupational clusters; references cited; survey methodology; regions of the United States; the survey instrument; research team members; and IT convocation task force summaries. Includes seven tables. (AEF)

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ED 420 316

# HELP WANTED 1998:

# A CALL FOR COLLABORATIVE ACTION FOR THE NEW MILLENNIUM

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# HELP WANTED 1998:

## A CALL FOR COLLABORATIVE ACTION FOR THE NEW MILLENNIUM

ITAA

Virginia Tech

VIRGINIA TECH 1998

## TABLE OF CONTENTS


Foreword ..... 3

Executive Summary ..... 4

Introduction ..... 6

Survey Goals and Process ..... 6

Results ..... 8

- Result 1: Reported IT Positions and Vacancies ..... 8
- Result 2: Education Requirements for Core IT Positions ..... 15
- Result 3: Retention and Hiring of Core IT Employees ..... 17
- Result 4: Strategies for Meeting IT Personnel Needs ..... 18
- Result 5: Training Challenges ..... 20
- Result 6: Training Providers ..... 22

Conclusion ..... 24

## APPENDICES


| | | |
|---|---|---|
| I. | Background on IT Workforce Issues | 25 |
| II. | Core Occupational Clusters | 30 |
| III. | References Cited | 32 |
| IV. | Survey Methodology | 36 |
| V. | Regions of the U.S. | 40 |
| VI. | Survey Instrument | 42 |
| VII. | Research Team | 51 |
| VIII. | IT Convocation Task Force Summaries | 53 |


## TABLES

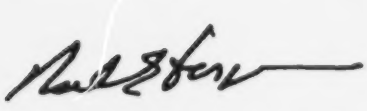

| | | |
|---|---|---|
| 1. | Estimates of IT Employees and Vacancies in the Three Core Occupational Clusters | 9 |
| 2. | Estimates of IT Employees and Vacancies | 11 |
| 3. | Education Requirements for the Three Core IT Positions | 15 |
| 4. | Retention and Hiring of Core IT Employees | 17 |
| 5. | Strategies for Meeting IT Personnel Needs | 18 |
| 6. | Training Challenges | 20 |
| 7. | Training Providers | 22 |

## FOREWORD

The digital information revolution is crucial to our country's competitiveness in a global economy. Every segment of our economy is affected. As we approach the millennium, we are at a very critical time in our history. Professionals are needed both to lead and to develop new products as part of this information revolution. Without a sufficient information technology workforce, projects will be delayed, industry growth will be constrained, trade will be affected, and productivity will decrease.

This research was completed by Virginia Polytechnic Institute and State University (Virginia Tech) in cooperation with the Information Technology Association of America (ITAA). Both organizations are committed to collaborative efforts to advance development of the information technology industry and to systematically create meaningful national policies on employment and training for information technology workers.

We call for other national leaders from professional associations, corporations, government, and education to collaborate on bringing about the positive leadership and decisive actions needed to advance information technology. Our focus is on creative problem solving to build the necessary information technology workforce for the next millennium.



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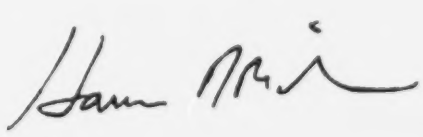

Harris Miller
President
ITAA

## EXECUTIVE SUMMARY

The digital information revolution is a new and dynamic way of maintaining competitiveness, responding to customers, defining customer needs for service and for new products, and improving organizational decision making. This revolution is strongly influencing every segment of our economy including information technology (IT) companies, banking, insurance, automotive, finance, retail, education, and government enterprises. The digital information revolution affects our everyday lives through the Internet; client/server networks; data mining and data warehousing for accurate customer research and development; organizational intranets designed to structure, access, and use information; and distance education.

This Executive Summary includes the major findings of a study conducted to enhance our understanding of the information technology workforce. Findings are based on responses to a telephone survey of a single representative from 532 companies, both IT and non–IT, with more than 100 employees. Results concerning IT vacancies represent estimates of *claimed* vacancies across approximately 104,000 U.S. companies. These numbers may differ from the numbers of vacancies that would be filled promptly if sufficient qualified applicants were immediately available.

Major findings are listed below.

- Larger companies and IT companies tended to report more IT positions and vacancies than their smaller and non–IT counterparts.

- Responses suggested that 346,000 IT positions were currently vacant in three core IT occupational clusters (programmers, systems analysts, computer scientists/engineers). There were 129,000 vacancies in 5,874 IT companies and 217,000 vacancies in 97,733 non–IT corporations with more than 100 employees.

- The 346,000 vacancies in the three core occupational clusters represented 10 percent of the total reported number of current core IT employees (3,354,000), or about 3 vacancies for each company.

- The estimated number of broadly defined IT vacancies was 606,000. The difference in number of vacancies between the global response (606,000) and the three core areas (346,000) is believed to represent the increasing diversity of IT positions in such areas as sales, technical writing, customer service, and training.

- The average number of IT vacancies per company did not vary significantly across regions of the country (Northeast, South, Midwest, and West). This was true even when the companies were broken down according to size and IT

versus non–IT status. For example, the average number of reported IT vacancies for medium–size non–IT companies did not vary significantly across geographic regions. This does not mean that regional differences do not exist, only that the data from the survey do not reveal any differences.

- A bachelor's degree was required by a very large proportion of IT and non–IT companies for "all" or "most" of the positions in the three core IT occupational clusters, regardless of size or geographic region.

- High percentages of respondents found it "very difficult" or "somewhat difficult" to hire personnel in the three core IT occupational clusters. A smaller percentage, but nevertheless the majority of respondents, also found people in these three job categories "very difficult" or "somewhat difficult" to retain.

- The two most challenging training issues were found to be the fast pace of changing technology and the difficulty of finding qualified trainers. Over 50 percent of respondents agreed "strongly" or "somewhat" that these issues made it more difficult to provide employee training.

- The two major sources of training for IT workers were in–house training departments and hardware/software vendors. Over 70 percent of respondents reported using these two sources "often" or "sometimes."

- Companies reported two major solutions for IT employee needs: (1) hiring new employees to respond to growth and (2) retraining existing staff. Of respondents, 91 percent and 88 percent reported these as the two major solutions, respectively.

## INTRODUCTION

This report contains the findings of a national survey on the IT workforce. The report is divided into three major sections: survey goals and process, results, and conclusion. The appendices include supplemental descriptive information. For those readers who are interested in first reviewing a background on the IT industry, one is provided in Appendix I.

## SURVEY GOALS AND PROCESS

The U.S. Commerce Department issued a warning that a severe shortage of workers in information technology could undermine U.S. innovation, productivity, and competitiveness in world markets. Cutting–edge technology would be inhibited. Other possible consequences of numerous IT worker vacancies could be constrained industry growth, loss of potential trade, and an increased cost of labor, resulting in an increased cost of doing business and lost productivity (U.S. Department of Commerce, 1997).
This study was undertaken to enhance our understanding of the IT industry and was part of a larger research initiative at Virginia Tech.

Virginia Tech's role in the study was to develop the survey instrument, conduct the survey, analyze results, and author this report. This study was funded by Virginia Tech's Division of Continuing Education as part of their program development initiative in IT (see Appendix VII for research team members). ITAA coordinated industry reviews of the survey instrument and report and funded the printing of this report.

Three major goals were established for this study. First, there was interest in verifying some of the results from Help Wanted: The IT Workforce Gap at the Dawn of a New Century (ITAA, 1997). These results concerned the total number of current vacancies within organizations, as well as vacancies projected for the next five years. Originally, these vacancies were broadly characterized as IT vacancies, with no specification as to the types of IT work they entailed. Therefore the first goal was to obtain more detailed information on positions and vacancies. The framework used to gather this information comprised the three "core IT occupational categories" defined by the Bureau of Labor Statistics: computer scientists/engineers, systems analysts, and computer programmers. The definitions of these core categories are in Appendix II. A second goal was to improve the rigor of the methodology to increase the total number of responses from IT and non–IT industries; identify any respondent bias; expand the survey to include small, along with medium size and large companies; and determine if any regional differences exist.

The final goal was to address selected issues and trends. These were selected from recurring themes in industry publications and anecdotal information about the IT

industry. These issues and challenges included: educational requirements, employee hiring and retention, strategies to address IT personnel needs, employee training, and training providers.

Current and projected vacancies were selected as key indicators for identifying workforce needs. Other studies have used both vacancies and wages to measure workforce requirements. Vacancies were chosen for this study as a concrete "real world" measure of the current situation. In addition, this choice allowed the comparison with the previous Help Wanted study and the ease of relating vacancies to other business issues.

The survey was conducted by telephone to increase company participation and to conduct the research in a timely manner. Appendix IV provides a detailed discussion of the methodology of this study. A brief overview of how the study was conducted is provided here to enhance understanding of the results.

The results of this study arose from a random sample of 1,493 U.S. companies. The sample, obtained from Dun & Bradstreet, was stratified by IT status (IT or non–IT) and size (100–499, 500–999, or 1,000+ employees). The companies were also classified according to geographic location (Northeast, Midwest, South, or West ) as shown in Appendix V. Approximately equal numbers of companies were surveyed in each region.

The survey was developed to inquire about the number of IT positions and vacancies in each company and to elicit information on specific issues (see Appendix VI for survey format and questions). Interviews were successfully completed with a representative from each of 532 companies. Reasons for nonparticipation were classified as resulting from either procedural problems (interviewee not available, constant busy signals, inability to get past phone mail system, etc.) or refusal (either spontaneous or as a result of company policy). Of the 961 failures to obtain interviews, 364, or 38 percent, resulted from refusals, while 597, or 62 percent, were classified as procedural. Accordingly, the response rate was 60 percent among telephone calls reaching the intended interviewee and 36 percent overall.

Statistical tests were conducted to investigate the possibility of nonresponse bias. This investigation revealed that larger companies and southern companies were more likely to respond than others. Therefore, the findings may be applied more confidently with respect to larger and southern companies.

## RESULTS

This section of the report summarizes the responses to survey questions by the 532 company participants. Results represent responses across almost 104,000 companies (5,874 IT and 97,733 non–IT companies) from which the sample was drawn. Survey results are provided on IT positions and vacancies, education requirements for core IT positions, hiring and retention of core IT employees, strategies for meeting IT personnel needs, training challenges, and training providers. The results are organized primarily around tables summarizing the data. The results are followed by a brief discussion of literature relevant to the particular issue.

Comparisons are made only to the first Help Wanted study, as appropriate. Comparisons to other reports may not be valuable because of the different methodologies and definitions used. These results can be viewed, then, as a snapshot of the respondents' current perceptions of the questions asked.

### Result 1: Reported IT Positions and Vacancies

Tables 1 and 2 summarize the responses about the number of IT employees and vacancies from three perspectives: (1) with respect to the three core IT occupational clusters (programmers, systems analysts, and computer scientists/engineers); (2) for IT employees not included in the three core categories; and (3) at the global level. Because of the complexity of the question concerning employees in other IT areas, the number of vacancies in this category was not explored. In the following discussion, persons holding these positions will be referred to as "other" IT employees.

These tables contain point estimates for population sizes based on the cell means for large (1,000+ employees), medium (500–999), and small (100–499) IT and non–IT companies (see Appendix IV for details). In addition, 90 percent confidence intervals were computed for each point estimate. The 90 percent confidence intervals for the total population estimates (IT and non–IT) ranged from +/– 9 percent to +/– 15 percent with the exception of the estimate of the number of systems analyst vacancies, which was +/– 19 percent. For the IT and non–IT populations, the confidence intervals were moderately greater, ranging from +/– 13 percent to +/– 21 percent for IT companies and from +/– 17 percent to +/– 33 percent for non–IT companies.

Although the actual population means have 90 percent probabilities of lying within the confidence intervals, it should be understood that these are *claimed* numbers of positions or vacancies. In particular, the number of vacancies that would be filled promptly, if qualified applicants became immediately available, may differ from the number of claimed vacancies.

Respondents were asked questions about positions and vacancies in the three IT core occupational clusters (programmers, systems analysts, and computer scientists/engineers) and about IT employees not included in the three clusters. These results are in Table 1.

**TABLE 1: ESTIMATES OF IT EMPLOYEES AND VACANCIES IN THE THREE CORE OCCUPATIONAL CLUSTERS**

| | IT COMPANIES (N = 5,874) | NON-IT COMPANIES (N = 97,733) | TOTAL (N = 103,607) |
|---|---|---|---|
| | | | |
| Total no. of core IT employees | 1,019,000 | 2,335,000 | 3,354,000 |
| Total of core IT vacancies & % of total core IT employees | 129,000<br>13% | 217,000<br>9% | 346,000<br>10% |
| | | | |
| Programmers employed & % of total core IT employees | 520,000<br>51% | 1,357,000<br>58% | 1,877,000<br>56% |
| Programmer vacancies & % of programmers | 60,000<br>12% | 128,000<br>9% | 188,000<br>10% |
| | | | |
| Systems analysts employed & % of total core IT employees | 197,000<br>19% | 721,000<br>31% | 918,000<br>27% |
| Systems analysts vacancies & % of systems analysts | 36,000<br>18% | 57,000<br>8% | 92,000<br>10% |
| | | | |
| Computer engineers/scientists employed & % of total core IT employees | 302,000<br>30% | 257,000<br>11% | 559,000<br>17% |
| Computer engineers/scientists vacancies & % of CE/S | 34,000<br>11% | 32,000<br>12% | 66,000<br>12% |
| | | | |
| No. of "other" IT employees | 37,000 | 229,000 | 266,000 |

A review of the job titles associated with the "other" positions indicated that some could have been included by respondents in the three core occupational clusters. Examples included database administrator, visual database modelers, applications support analysts, network administrator, LAN technical specialists, and hardware engineers. However, the majority of the "other" positions did not conveniently fit within the three

core clusters. A sampling of such job titles or IT areas included project manager, team leader, customer support representatives, telecommunications specialists, business analysts, project consultants, facilities analysts, technical writers, sales personnel, IT trainers, vice president of MIS, chief of information systems, graphic artists, procurement personnel, liaison relationship managers, testers, quality assurance personnel, and clerical support staff. Many of these represent leadership positions. Some of these positions could certainly be filled by programmers or systems analysts (for example, IT trainers, project consultants, etc.). Others represent strong emerging areas in IT—for example, customer support, sales, and technical writing positions.

Survey participants were also asked to respond to some global questions about positions and vacancies in their companies. These results are reported in Table 2. Note the positions and vacancies for the three core IT occupational clusters and the "other" IT workers covered in Table 1 as compared to the global responses concerning positions and vacancies in Table 2. The total number of positions reported for programmers, systems analysts, computer scientists/engineers, and "other" IT workers in Table 1 is 3,620,000, compared to 10,208,000 IT positions reported in response to the global question concerning the number of IT positions as shown in Table 2. Clearly, with respect to specific job classifications, respondents estimated substantially fewer positions.

With regard to the estimate of total numbers of IT employees (10,208,000). The questions that elicited the response estimates reported in Table 2 relied on a very broad definition of IT employee and were the first questions asked in the survey. In part, the purpose of those questions was to have respondents provide overall estimates of those employees in their companies that have virtually any IT–related duties or responsibilities. We believe these larger numbers are attributable to the broad definition used; yet, we believe they are an accurate assessment of IT and IT–related employees across the United States. We also believe that the point estimates of the present study represent an unbiased averaging of the responses that companies nationwide would make to the survey regardless of company size or whether they were IT or non–IT(see Appendix IV).

## TABLE 2: ESTIMATES OF IT EMPLOYEES AND VACANCIES*

| | IT COMPANIES (N = 5,874) | NON–IT COMPANIES (N = 97,733) | TOTAL (N = 103,607) |
|---|---|---|---|
| | | | |
| Total no. of IT employees | 1,977,000 | 8,231,000 | 10,208,000 |
| | | | |
| Total no. of IT vacancies | 201,000 | 405,000 | 606,000 |
| | | | |
| No. of IT vacancies to be filled in next five years | 1,174,000 | 2,048,000 | 3,222,000 |

*Globally defined (see questions 2a, 2b, 3, and 4 in Appendix VI: Survey Instrument) and extrapolated from the 532 responding companies

Regarding the relatively small totals included in the "other" category, participants could name numerous "other" IT positions and the number of employees in each type. However, no respondent named more than three, and the estimated population total for these positions was only 266,000.

A similar outcome was observed with respect to vacancies. The estimated number of IT vacancies, broadly defined, was 606,000, whereas the sum of estimated population vacancies for programmers, systems analysts, and computer scientists/engineers was 346,000. It seems reasonable to surmise that the preliminary questions about positions and vacancies elicited responses that included many categories of workers that were involved in IT in some way, such as management, marketing, sales, customer service, and training.

Statistical analyses were performed to evaluate variation in the numbers of positions and vacancies according to geographic area (Northeast, South, Midwest, West); size (small, medium, large); and IT status (IT, non–IT). Not surprisingly, larger companies and IT companies tended to report more IT positions and vacancies than their smaller and non–IT counterparts. However, two other results were of interest. Small and medium–size non–IT companies tended to report about the same number of total IT vacancies, whereas medium–size IT companies tended to report somewhat more IT vacancies than smaller IT companies. A similar result was observed for the number of IT vacancies to be filled within the next five years. This phenomenon was present, although not in such pronounced form, for the specific vacancies in programmer, systems analyst, and computer scientist/engineer positions.

Geographic region was not a statistically significant factor in any of the analyses just described. Accordingly, results are not presented by geographic region. This decision was made because presenting results by region could be misleading, given that observed regional differences can arise from chance factors such as the vagaries of sampling. That is, the observed regional differences cannot be attributed to variation

in size and IT status composition across the regions or to anything other than chance factors. This does not mean that regional differences may not exist, only that the present data do not reveal them.

Four observations about these results are warranted. First, the inclusion of businesses with 100 – 499 employees in the present research distinguishes it from the earlier ITAA study reported in 1997. Though the response rate for these smaller companies was not as good as the larger ones, it was nevertheless substantial. Point estimates for numbers of "core" IT employees and vacancies in the population of about 83,000 smaller companies are shown below.

"SMALL" COMPANY ESTIMATES IN THREE CORE OCCUPATIONAL CLUSTERS

| | |
|---|---|
| Number of programmers employed | 706,000 |
| Number of programmer vacancies | 62,000 |
| Number of systems analysts employed | 227,000 |
| Number of systems analyst vacancies | 31,000 |
| Number of computer engineers employed | 203,000 |
| Number of computer engineer vacancies | 24,000 |
| Number of "other" IT employees | 107,000 |

In comparison to the overall vacancy rate in the three "core" occupational clusters, the vacancy rate for "small" companies is similar: 10.1 percent as compared to the overall 10.3 percent.

"SMALL" COMPANY ESTIMATES OF ALL IT EMPLOYEES

| | |
|---|---|
| Total number of IT employees (broadly defined) | 2,273,000 |
| Number of IT vacancies (broadly defined) | 231,000 |
| Number of IT vacancies to be filled in next 5 years | 1,156,000 |

These numbers, for the most part, make up about one–third of the total numbers of estimated positions and vacancies. In other words, the smaller companies appear to account for about one–third of IT employment activity.

A second observation is that these results seem to convey a very strong sense of need by these companies. The reader is cautioned again that, even if 346,000 qualified applicants in the core occupational clusters appeared today, in all probability immediate positions would not be available—to translate this number to an absolute would be misleading.

The responses on vacancies are supported by anecdotal information in the literature and other reports. Each week, online and paper publications such as *InternetWeek*, *Computerworld*, *InformationWeek*, among others, present examples of how the reported shortage of skilled IT workers affects industry and business, IT and non–IT alike. A sample of these is provided below.

- "Because of a number of driving factors that are coming together at once, there is a skills shortage from staff level to executive level" says Tom Lesica, CIO of PepsiCo's international business in InformationWeek Online. The "driving factors" include reengineering projects; year 2000 work; enterprise resource planning deployments; telecommunications network expansion; Internet, intranet, and Java initiatives; and globalization (Violino & McGee, 1997).

- Nancy Lewis, Microsoft's general manager for worldwide training and certification, completed a poll of their key integrators and resellers in its distribution channel. An average of three open positions in each company was found. "Most companies in the poll said they would create substantially more new positions if they thought they could fill them." That conclusion, plus a look at all the potential jobs that could be filled by Microsoft customers and sales channels, has convinced Lewis that the number of potential job openings for IT workers is closer to 450,000" (Cone, 1997).

- Booz–Allen & Hamilton Inc. has about 700 vacancies in its worldwide staff of 5,000 technology services employees. According to its chairman, William F. Stasior, "If we had those people today ... We could probably be generating another $50 million worth of revenue a year" (Behr, 1997).

- Trey Bradley, CIO of Mary Kay Inc. in Dallas says the 40 openings in the company's 250–employee IT department is problematic. "All of our big projects, including financials and manufacturing systems, have gone over budget and over schedule." He is so eager to hire qualified IT workers that Mary Kay is offering $2,500 for leads that result in hires (Cone, 1997).

- "If I had to provide a one–line summary of all the viewpoints it would be—the shortage is real and its impact will dwarf the techno–issues such as the Internet, e–commerce, and HDTV, which are the focus of media attention today" (Rubin, 1997).

A third observation is that respondents reporting some 10 million IT employees may be consistent with the current variety and types of positions. Current employment in high tech reflects a wide diversity of positions defined as core industries (computers, software, and communications), associated industries (high–tech sales, repairs, management, and consulting), and others (programmers, network technicians, etc.) (Mandel, 1997). The booming tech sector is creating 40 percent of all new managerial and professional positions, outside of the health and education sources. If this trend continues, it can be expected that high tech will be the single biggest source of new managerial and professional jobs in the coming years (Mandel & Gutner, 1997).

A fourth observation is that those responding to the survey were very optimistic about continued IT growth and expansion. They projected filling some 3.2 million vacancies in the next five years. Given that a large majority of this accelerated IT growth has occurred in the last few years, it is difficult to predict if such expansion will continue or what the future will hold. The survey responses do represent a very positive view of the future, with sustained innovation and productivity in the IT industry.

**Result 2: Educational Requirements for Core IT Positions**

Table 3 below summarizes responses specific to the three core IT occupational clusters (programmers, systems analysts, and computer scientists/engineers) with respect to levels of education required. A bachelor's degree was required for "all" or "most" of the positions in the three core clusters by a very large proportion of IT and non–IT companies.

**TABLE 3: EDUCATION REQUIREMENTS FOR THE THREE CORE IT POSITIONS**

| | PROGRAMMER[1] | SYSTEMS ANALYST[2] | COMPUTER SCIENTIST/ENGINEER[3] |
|---|---|---|---|
| | | | |
| Require a bachelor's degree for "all" or "most" | 83% | 82% | 90% |
| | | | |
| Require no more than a 2–year program for "all" or "most" | 12% | 14% | 6% |

[1] n = 444–453 respondents [2] n = 438–441 respondents [3] n = 264–266 respondents

The U.S. Commerce Department reports that no universal standard exists for most of these positions (1997), but that in most cases, only individuals with a bachelor's degree are hired. The 1996 Utah Information Technologies Industry Report identified the minimum educational requirements for some positions as being less than a four–year degree. For some systems administrators, computer engineers, and programmers, companies required only a two–year degree (Wirthlin Worldwide, 1997). Newsweek reports that a 17–year–old high school senior, upon graduation will take a $30,000 year job as a systems engineer; his credentials include Microsoft certification, but no college degree (Hafner & Meyer, 1997).

The percentages reported in this study are similar to those reported in the 1997 Help Wanted report for positions requiring a bachelor's degree. As noted above, however, the accelerated growth rate of the industry may be bringing about changes. Although those companies responding required, for the most part, a bachelor's degree, there is evidence that individuals with lesser educational qualifications are being hired to meet IT personnel needs.

Changing educational requirements for some IT positions does not mean that the bachelor's degree will become unimportant. There will continue to be a requirement

for a bachelor's degree or above for work requiring higher levels of analytical knowledge and ability.

Educational requirements for of IT industry positions are drawing the attention of the IT industry, professional associations, and educational institutions. For example, Northwest Center for Emerging Technologies (Washington), the Software Human Resources Council (Canada), and the Australian Computer Society are pioneering efforts to define specific education and skill requirements for specific IT positions. These efforts deal not only with the technical skills required but also with interpersonal and leadership skills as well. These types of initiatives will make employee access to the IT industry easier.

**Result 3: Retention and Hiring of Core IT Employees**

High percentages of respondents found it "very difficult" or "somewhat difficult" to hire personnel in the three core IT clusters. Smaller proportions, but nevertheless majorities, found employees in these three job categories "very difficult" or "somewhat difficult" to retain, as shown in Table 4. Statistical analyses revealed no significant variation in the responses with respect to size, IT status, or geographical region.

**TABLE 4: RETENTION AND HIRING OF CORE IT EMPLOYEES**

| | PROGRAMMER[1] | SYSTEMS ANALYST[2] | COMPUTER SCIENTIST/ENGINEER[3] |
|---|---|---|---|
| "Very difficult" or "somewhat difficult" to hire | 85% | 78% | 84% |
| "Very difficult" or "somewhat difficult" to retain | 58% | 59% | 65% |

[1] n = 444–453 respondents [2] n = 438–441 respondents [3] n = 264–266 respondents

When a worker shortage does indeed exist, two of the best indicators are difficulty in hiring and retaining employees. InformationWeek reported in a survey that 80 percent of IT managers had experienced computer programmers voluntarily leaving their jobs in the last year, and a quarter of the managers surveyed reported that the number of departed employees was in excess of 10 percent their organization's total programming staff (Cone, 1997).

Inability to retain employees may also exaggerate the perceived size of an IT worker shortage. Job–hopping results in a greater number of openings which do not represent new positions created within the industry. However, these are still vacancies. In many instances, the highest turnover rates can be found among the highest paying positions, often the computer scientists and engineers (Melymuka, 1997).

**Result 4: Strategies for Meeting IT Personnel Needs**

Companies reported that hiring new employees and retraining existing staff members are the two most used methods to meet IT personnel needs (as shown in Table 5 below). Respondents reported these as the two major solutions, at 91 percent and 88 percent respectively. Approximately 75 percent of the respondents use consultants or temporary workers. It is interesting to note that less than half of the respondents hire new immigrants and significantly fewer outsource to non–U.S. contractors.

Statistical analyses of the data revealed that responses differed with respect to size and type of company for questions concerning outsourcing to non–U.S. contractors and hiring new immigrants. Outsourcing as a solution was reported by 10 percent of small and medium size companies "often" or "sometimes," whereas 21 percent of large companies reported this solution "often" or "sometimes." Of IT companies, 51 percent reported hiring recent immigrants "often" or "sometimes", versus 27 percent of non–IT companies. These differences in responses would have been anticipated.

**TABLE 5: STRATEGIES FOR MEETING IT PERSONNEL NEEDS***

| | % OFTEN OR SOMETIMES |
|---|---|
| Hire new employees | 91% |
| Retrain existing staff | 88% |
| Use consultants/temporary workers | 74% |
| Hire new immigrants | 40% |
| Outsource to non–U.S. contractors | 16% |

* n = 484–506 respondents

The responses to this question were consistent with reports in the literature. A shortage of skilled IT workers has prompted numerous organizations to pursue alternative solutions to their staffing needs. While retraining existing staff may appear to be the most obvious source of requisite talent, and is used extensively by those responding, it also appears to be insufficient.

Aggressive hiring and recruiting strategies are rampant, according to reports. Coopers & Lybrand reported that 85 percent of companies surveyed plan to increase hiring in 1998 (Computerworld, 1997). "Bounties" for employee referrals are quoted to be as high as $15,000 for a key IT hire, company stock options are the norm, and company culture is changing to reflect the relaxed, creative environment that many IT

professionals prefer (USA Today, 1997b). In fact, many new benefits have become extremely important to the IT professional. These benefits include amenities such as gyms and exercise facilities, day care, restaurants, medical assistance, flexible work schedules, and increased vacation time (Cone, 1997).

Three–quarters of the respondents are using consultants and temporary contract employees to fill the gap of IT workers. While the use of contract labor can be expensive, companies recognize that some savings occur because these temporary workers are not provided with many of the costly benefits of regular employees. Some concern is expressed, however, with the fact that contracted staff may bring less dedication to a company (Mosquera, 1998). Contract employees are not affected by the overall performance of the company for which they work; their pay does not depend on overall organizational effectiveness. If more professionals become less loyal to their companies, the number will increase among those who relocate for project opportunities and their own career advancement.

Outsourcing to non–U.S. contractors, while controversial, has been adopted by organizations seeking an economical source of labor. According to an InformationWeek (1997) survey, companies are devoting 15 percent of their IT budgets to outsourced services. Larger companies in this survey use this strategy more frequently. For example, approximately 8 percent of Microsoft's 16,000 U.S. employees are on temporary visas (Mosquera, 1998). India, with 200,000+ programmers, has a wealth of IT workers (U.S. Department of Commerce, 1997), and countries such as Israel, that invest heavily in research and development, are not hindered by remote geography, because software can be transmitted around the planet in microseconds. Israel also has the highest proportion of engineers in the world—135 engineers per every 10,000 citizens (USA Today, 1997a).

Hiring new immigrants is another possible solution and is a strategy used more by IT companies than by non–IT companies , according to this study. Boomtowns with a low cost of living, cultural offerings, and ethnic diversity are able to ease their worker crunch by luring skilled immigrants, especially from Asia (U.S. News and World Report, 1997).

**Result 5: Training Challenges**

Table 6 concerns the training challenges that respondents were requested to evaluate. The two most challenging issues were found to be the fast pace of changing technology and the difficulty of finding qualified trainers. Over 50 percent of respondents agreed "strongly" or "somewhat" that these issues were of greatest concern.

Almost 50 percent of the respondents "strongly or somewhat agreed" that they were concerned about employees leaving after training. Only a third "strongly or somewhat agreed" that an insufficient budget was a training problem.

Statistical analyses revealed differences in responses with respect to company size. Only 37 percent of medium size–companies reported that employees' leaving after training was a problem "often" or "sometimes," whereas 48 percent and 51 percent, respectively of small and large companies reported this as a problem "often" or "sometimes." This difference may imply that "job hopping" is more prevalent in small and large companies.

**TABLE 6: TRAINING CHALLENGES***

| | % STRONGLY OR SOMEWHAT AGREE |
|---|---|
| | |
| Fast–changing technology | 64% |
| | |
| Availability of qualified training providers | 54% |
| | |
| Employees' leaving after training | 46% |
| | |
| Insufficient training budgets | 36% |

* n = 472–504 respondents

The issue of training challenges is extremely important to the IT industry. In a survey by InformationWeek, training was found to be the number one technique used by IT managers to attract and retain information technology professionals (Cone, 1997). There are many anecdotal reports of IT professionals who remain with their current employer because of the quality of training provided.

It was not surprising in the booming IT industry that the changing pace of technology was the major challenge facing companies. By necessity, companies look for "just–in–time" training for employees to take advantage of changing technology. Companies want the training tailored to their business needs. This need for timely response and

for training that is customized to the strategic corporate needs within the company may have resulted in the large number of companies that reported difficulty finding qualified providers.

Companies confirmed anecdotal information that employees' leaving after training is an issue. Employees who gain new skills may tend to migrate to better paying positions. Employers perceive they are spending large amounts of money training employees who will leave before a return on the training investment is realized (Maclachlan, 1998).

Only one–third of the respondents reported insufficient training budgets to be a challenge. The fact that two–thirds of those responding do not consider this a challenge tends to support the growing importance of training related to company performance.

**Result 6: Training Providers**

In Table 7, the sources used most frequently for training are identified. The two major providers of training are the internal training departments and the hardware and software vendors. Over 70 percent of the respondents reported using these two sources "often" or "sometimes." Some 60 percent use private training companies "often" or "sometimes."

Institutions of higher education are used less frequently, although some 50 percent use these "often" or "sometimes." Statistical analyses regarding the use of four–year colleges and universities revealed differences in responses with respect to company type. Only 18 percent of non–IT companies reported using four–year colleges and universities for training "often," whereas 31 percent of IT companies reported use of this training source "often." This outcome was reversed for the response of "sometimes," (25 percent of IT companies and 32 percent of non–IT companies).

**TABLE 7: TRAINING PROVIDERS***

| | % OFTEN OR SOMETIMES |
|---|---|
| Company training departments | 76% |
| Hardware/software training vendors | 74% |
| Private IT training companies | 62% |
| Four–year colleges & universities | 53% |
| Two–year colleges & technical schools | 47% |

* n = 483–490 respondents

The number and types of training resources are expanding at a tremendous rate. Corporate spending on training and education reached an estimated $16 billion in 1996, with $3 billion going to universities and the rest going to in–house programs and consultants (Reingold, 1997).

Finding qualified training providers was a challenge for over 50 percent of the survey respondents. This may be one reason that internal training departments are used more frequently than any other provider. But there are other reasons, as noted earlier. Companies prefer to have training customized to their specific needs and corporate strategies. This requirement for customization and the difficulty in finding suitable

providers accounts, in part, for the growth of corporate universities, which have grown in number from only 400 in 1989 to 1200+ (Davis & Botkin, 1994).

Three–quarters of the respondents used hardware and software vendors for training. Private IT training companies provide many of the same benefits as hardware and software vendors in terms of flexibility, willingness to customize, and quick response for just–in–time training.

Institutions of higher education were not used as providers as frequently, but they were used "often" or "sometimes" by approximately half the respondents. Response time may be one of the major reasons they are not used more frequently. However, many exciting examples of partnerships between higher education and the corporate world can be found across the country. These partnerships enhance communication, learning opportunities for the IT workforce, curriculum development, and research, and will strengthen higher education's training contribution to the high–tech industry.

Numerous resources are available for training purposes as discussed above. The question for the future may be how each of these individual providers of training can work together in partnership to provide needed training that is consistent with their core competencies. The partnership approach may be one way that more qualified training providers can be provided to the IT industry.

## CONCLUSION

This report contained the responses of representatives from 532 IT and non–IT companies. The responses were obtained in a telephone survey during November and December 1997. The data suggest several conclusions.

- Responding companies report a large number of vacancies in the three core IT occupational clusters (programmers, systems analysts, and computer scientists/engineers) and in other IT–related positions. Companies report difficulties in hiring and retaining IT employees, which contribute to a perceived worker shortage.

- Companies are using multiple strategies to meet their IT personnel needs. This multiple strategy approach seems to indicate flexibility in choosing those strategies most consistent with their business environment.

- Of those responding, about half report an inability to find qualified training providers. Partnerships among corporations, education, government, and professional associations at national and regional levels may provide the necessary infrastructure for orchestrating positive leadership and meaningful change. These partnerships could address how each segment can support IT education and training. Partnerships can provide an impetus for major educational and training providers to fill specialized niches consistent with their missions.

- The majority of those responding require a bachelor's degree for the positions in the three core IT occupational clusters. At the same time, there is evidence of a growing diversity of new positions in IT. Clear career pathways and associated skill requirements may increase the ease of entry and recruitment into IT positions. This will be especially helpful for individuals seeking retraining, especially since retraining is used by the overwhelming majority of respondents to meet IT personnel needs.

All research conclusions point toward action and creative problem solving. Included in Appendix VIII of this report are summaries and recommendations from six task forces that were part of the 1998 National Information Technology Workforce Convocation. Leaders from corporations, government, education, and professional and trade associations participated. Their participation was directed toward creating ways to meet needs identified from this research and from their own professional experience.

# APPENDIX I

# BACKGROUND ON IT WORKFORCE ISSUES

## BACKGROUND ON IT WORKFORCE ISSUES

Resounding phrases echo throughout the information technology (IT) workforce: a call for decisive action, positive leadership, collaborative and creative problem solving; these are phrases used among the corporate, educational, and governmental worlds to rally a national focus on strengthening leadership in information technology for a vibrant U.S. economy.

Information technology is no longer an isolated arena catering only to computer companies. In the United States, 65 percent of all workers use some type of technology in their jobs (Educational Record, 1995). Information technology also extends into U.S. homes; the United States ranks first in terms of computers per capita, with approximately 390 per 1,000 people (Rubin, 1996). Furthermore, the demand for new media and interactive games, biotechnological advances in medicine, and the upcoming millennium provide a threshold for information technology to touch all people.

With the present shift in the economy, the manufacture of knowledge has become more economically valuable than the manufacture of industrial goods (Davis & Botkin, 1994). The overall structure of the economy is not only affected by the rapid growth of technology, it is also being changed by technology itself. A new industrial sector is emerging from the convergence of computing (computers, software, services); communications (cable, satellite, wireless); and content (entertainment, publishing, information providers) (Tapscott, 1996).

Nationally, the high–tech industry yielded 27 percent of the growth in GNP over the past three years, and high–tech jobs accounted for 20 – 25 percent of the real wage or salary growth in the past year. The high–tech industry has also had a huge effect on the stock market, with returns averaging 35 percent in 1996 (Bureau of Economic Analysis, 199?). High–tech industries are growing at an annual rate in excess of 5 percent, considerably faster than the rest of the economy. It is estimated that high–tech industries currently employ some 9.1 million people (Mandel, 1997).

Furthermore, this impact is expected to increase as the nature of work continues to shift: in 1950, some 60 percent of all jobs in the United States were unskilled; that is about 25 percent today, and will shrink further to 15 percent by the year 2000 (U.S. News Online, 1997). The booming tech sector is creating 40 percent of all new managerial and professional positions, outside of the health and education sources. If this trend continues, it can be expected that high tech will be the single biggest source of new managerial and professional jobs in the coming years (Mandel & Gutner, 1997).

The economic impact of the IT industry is not limited to its role in employment. The American Electronics Association reports that technology accounts for $150 billion in

exports, and that technology firms spend more money on research and development than any other industry, approximately $40 billion (Thibodeau, 1997).

The whirlwind change occurring in information technology is staggering. The overwhelming majority of survey respondents are struggling to find new employees to hire and training providers to retrain existing employees to meet IT industry needs. Today, networking and other information technologies that connect individuals and firms into local, regional, national, and international markets are essential to sound economic growth and development. As in prior years when growth depended on access to waterways, railroads, highways, and airports, success in today's environment requires proficiency in the application of information technology (AIM, 1998).

Three major forces are at work driving the need to hire new employees and retrain existing employees. First, consider the impact of the World Wide Web and net–based commerce on our work and personal lives. Consider the following:

- There were an estimated 40 million people who went online in 1997, up from 27 million in 1996 (Schnabel, 1998).
- It is estimated that between 1995 and the year 2000, home access will have grown from 10 to 46 percent (Tapscott, 1998).
- In January 1993, there were only 50 known web servers. By October 1993, there were more than 500. By the end of 1994 there were 5,000. And by the end of 1997, there were more than 1.5 million web sites (Tapscott, 1998).
- Jupiter Communications, an Internet consulting firm, estimates that there was $2.6 billion in total on–line sales in 1997 (Schnabel, 1998).
- All predictions point toward a continuing expanding role for net–based commerce for retail and businesses. Researchers are forecasting at least $7.5 billion in consumer retail sales by the turn of the century. Electronic commerce accounted for $600 million in business–to–business spending in 1996, with $65 billion in transactions predicted by Forrester Research for the year 2000 (Tapscott, 1998).

It is very easy to understand the increasing demand for skilled IT employees. The facts reported above cover a period of only about four years. This explosive growth demonstrates an overwhelming demand for new products and services. It is evident why the survival and growth of companies are dependent on having competent and skilled IT employees who are able to function in high–stress environments to bring innovative products to market. Huge demand, coupled with the need to stay ahead of competitors, helps to explain the large number of positions to be filled, especially programmer positions. In this study, "programmer" includes not only those who produce code but also those who implement new platforms, such as web developers. Many different types of programmers are needed in the area of retail and business electronic commerce.

Electronic commerce is also driving the increasing diversity of IT employees in customer service, marketing, sales, technical writing, project management, human resources, and finance. Finding employees for many of these professional positions is extremely difficult because of the combined requirements for experience in a field, such as sales, along with some technical knowledge.

Another key issue of concern is the year 2000 conversion. The scope of this problem is staggering. Consider the following:

- The Yankee Group estimates that the cost of year 2000 staffing for the 5,000 largest U.S.–based multinational companies will be $50 billion. And solving the problem is going to require an additional 275,000 programmers (Kirsner, 1998).
- Most of the year 2000 conversion will be focused only on critical systems. There is an estimated 180 billion lines of code that have to be rewritten (Zuckerman & DeBarros, 1997).
- Estimates for the cost of addressing the federal government conversion problems stand at $3.87 million. This figure doesn't include the $27 billion in funds that are earmarked for technology spending by the federal government, much of which is already being applied to the conversion problem (Zuckerman & DeBarros, 1997).
- As much as $50 billion worth of software in North America that cannot be reprogrammed will stop working on the last day of 1999. The source programs have been lost or destroyed, and the original programmers have retired or died (Tapscott, 1996).

The influence of the Internet and the year 2000 conversion problem provide perspective for understanding the changing nature of the workplace. The way we work and learn is going through a major transition.

Decisions required in "real time" are now becoming the norm. This necessitates information that is rapidly available to large numbers of people distributed in numerous work sites. Work and project teams are also becoming the norm, with systems that provide immediate information for new product development and decision making. The ability to manage these large amounts of information has become a requirement. The future is based on a work environment and culture that fosters innovation, customer service, and responsiveness.

Many innovations have to be introduced in a matter of weeks rather than months or years. The fast pace of changing technology and stress also heightens the need for a new type of leader who can communicate well, deal with complexity, manage change, provide knowledge management, negotiate, and work effectively on site and at other geographical locations with a wide diversity of employees and customers.

Consider a small number of innovations that change the nature of work.

- At Mercedes Benz's Alabama factory, laser gauging equipment ensures the quality of every new Mercedes Benz class sport utility vehicle. This equipment allows the car maker to do a 100 percent inspection on every vehicle's dimensions (84 measurements, to be exact) in about 45 seconds; an impossibility with human inspectors (Brown, 1998).
- The Titleist/Foot–Joy Corporation is using advanced computer technology to create custom made, perfectly fitting golf gloves, which are made to the precise dimensions of the customer's hands.
- The success of Federal Express is now legendary because of the company's speed and the way it uses the Web to involve the customer in parcel tracking.
- Wal–Mart uses information technology to build partnerships with suppliers and employees to effectively maintain inventory levels. Data mining is used to understand changing customer demographics and needs in order to design advertisements and stock merchandise.

In summary, the growth in demand for information technology and competent and skilled IT employees in the past four years has been overwhelming. This accelerated growth has resulted from e–commerce, the year 2000 problem, and the changing nature of work.

# APPENDIX II

# CORE OCCUPATIONAL CLUSTERS

## CORE OCCUPATIONAL CLUSTERS

Descriptions of the core occupational clusters identified from the Bureau of Labor Statistics are provided below. These descriptions will be helpful when viewing results.

**Who are Computer Programmers?** According to the Bureau of Labor Statistics, computer programmers write and maintain detailed instructions that tell computers how to execute their functions (Bureau of Labor Statistics, 1997). Some examples of job titles include software developers, database programmers, programmer analysts, and web developers.

These are individuals who list in logical order the steps a computer follows in order to work. The emergence of the Internet has opened numerous new venues for programmers and created a demand for several new languages, including Java, C, and C++. The year 2000 conversion problem also has increased the need for programmers skilled in mainframe languages such as COBOL.

**Who are Systems Analysts?** Systems analysts are the problem solvers of computer technology. They use their skills to address the individual computing needs of an organization—to solve business application problems. This solution may involve creating new computing systems or finding new ways to apply existing systems to meet the need at hand.

Systems analysts may also be involved in connecting the multiple computers within an organization so they can communicate with one another—networking. Networking involves ensuring that computer systems are compatible with one another and are able to share information that is important to different users (Bureau of Labor Statistics, 1997). Today's new client/server hardware and software and the Internet–based applications have significantly increased the demand for systems analysts. Examples of systems analysts job titles are systems integrators and network administrators.

**Who are Computer Scientists and Engineers?** Computer scientists and computer engineers often perform many of the same duties as other computer professionals, but they are distinguished by a higher level of theoretical expertise and innovation, which they use for solving complex problems and creating new technology (Bureau of Labor Statistics, 1997). In general, computer scientists design computers, find ways to improve the use of computers, and look for new areas in which to apply computers. Computer scientists may include database administrators, computer support analysts, and specialists such as theory or language developers. Computer engineers are categorized as a subcomponent of computer scientists by the Bureau of Labor Statistics. These are the professionals who are responsible for designing and developing both packaged and systems software and hardware. They may design new computing devices or computer–related equipment. Computer scientists and engineers may be employed in academics or private industry.

# APPENDIX III

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## REFERENCES CITED


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# APPENDIX IV

# SURVEY METHODOLOGY

## SURVEY METHODOLOGY

Included in this Appendix is information on who participated in the survey, how the survey instrument was developed, how the survey was conducted, and how the results were analyzed.

### Survey Participants

A random sample of 1,500 U.S. companies was obtained from Dun & Bradstreet from approximately 104,000 companies. The sample was stratified according to size and IT status, with equal numbers of cases representing small, medium, and large IT companies and small, medium, and large non–IT companies. Small companies were those with 100 to 499 employees, medium companies had 500–999 employees, and large companies had 1,000 or more employees. Companies with fewer than 100 employees were not included because of the potential for selecting large numbers of companies with no IT employees.

IT status was based on the U.S. Department of Commerce Standard Industrial Classification (SIC) codes. IT organizations are those with a primary SIC code of 3571 (electronic computers), 3572 (computer storage devices), 3575 (computer terminals), 3577 (computer peripheral equipment), 3674 (semi–conductors and related devices), 4812 (radio/telephone communications), 4813 (telephone communications, except radio), 4822 (telegraph and other communications), 3661 (telephone and telegraph apparatus), 3663 (radio and TV equipment), 7372 (prepackaged software), 7373 (computer integrated systems design), 7376 (computer facilities management), 5045 (computer peripherals and software), 7374 (computer online services, Internet), 7379 (computer related services, not classified elsewhere), 8742 (computer systems analysis services), 8243 (data processing schools), and 7371 (computer programming and software development). Non–IT companies were defined by the remaining SIC codes, with the exception of those designated as nonprofit organizations, educational institutions, or those in the governmental sector.

The sample was later reduced to 1,493 companies. Four sample companies were duplicates, and three were dropped because of respondents who provided answers that were highly inappropriate or absurd.

Regions of the United States were defined in a manner that yielded four geographically consistent areas that split the sample into approximately equal numbers of cases. These areas are referred to as Northeast, Midwest, South, and West. See Appendix V for a map delineating these regions.

## Survey Instrument Development

The telephone was selected as the medium for conducting the survey. This choice was made in order to increase participation, timeliness, and accuracy of responses.

Survey questions were drawn from two sources. Some were adapted from the 1997 ITAA Help Wanted study, mainly to provide information on trends. Others arose from an extensive review of the literature. The IT industry issues underlying these questions were identified in the media, government reports, books, periodicals, and trade and professional organizations.

A preliminary version of the survey was pilot–tested on 18 companies, three from each IT and non–IT size category. Based on this feedback, revisions were made in the survey instrument for clarification and to control the amount of time required to answer the questions. The revised instrument was then pilot tested with an additional six companies.

A final revision of the survey was made in order to conduct the survey within seven minutes. This decision was made cooperatively by representatives of Virginia Tech and ITAA who participated in content development for the survey. The final survey instrument is included in Appendix VI.

## Data Collection and Analysis

The survey was conducted by the Virginia Tech Center for Survey Research. This center has state–of–the–art, computer–supported facilities for conducting telephone surveys. It used 12 highly trained and experienced interviewers during the period of November 12, 1997, through December 17, 1997. Before the telephone calls began, a letter was sent to chief executive officers of those companies selected. It explained the purpose of the survey and requested participation. The interviewers spoke to the director of human resources or to someone with a comparable grasp of each company's personnel situation. Titles of other individuals included manager, IT Human Resources; recruiting manager; VP Information Systems; VP Resources and Systems; Manager, Employment and Training.

Reasons for nonparticipation were classified as resulting either from procedural problems (interviewee never available, constant busy signals, inability to get past phone mail system, etc.) or refusal, either spontaneous or as a result of company policy. Of the 961 failures to obtain interviews, 364, or 38 percent, resulted from refusals, while 597, or 62 percent, were classified as procedural. An average of 7.4 attempts were made to call each non–respondent company. The Survey Center provided a file containing data for all 1,493 sampled companies. All records in this file contained the information from the Dun & Bradstreet file (SIC code, size, ZIP code, etc.). For nonrespondents, the reason for nonresponse was provided; for successfully completed interviews, all responses were included in the data vector.

To evaluate the possibility of nonresponse bias, sample companies were classified as participants, nonparticipants because of procedural problems, and nonparticipants because of refusal. Two–way chi–square tests contrasted this categorization with size, IT status, and geographic region. Two of these tests yielded chi–squares with probabilities of less than .01. Inspection of the corresponding cross tabulations indicated that this outcome reflected a greater tendency to respond among large companies (1,000+ employees) and southern companies. Specifically, 42 percent of the large companies participated versus 31 percent of the medium and small companies. Of southern companies, 43 percent participated, versus 33 percent of companies in other locations.

Three–way factorial analyses of variance were performed on all responses reporting numbers of positions or vacancies. The independent variables were size of company (small, medium, or large); IT status (IT or non–IT); and geographic region (Northeast, Midwest, South, or West). The results of these analyses are presented in the body of the report based on F tests with probabilities of less than .01 for Type III sums of squares.

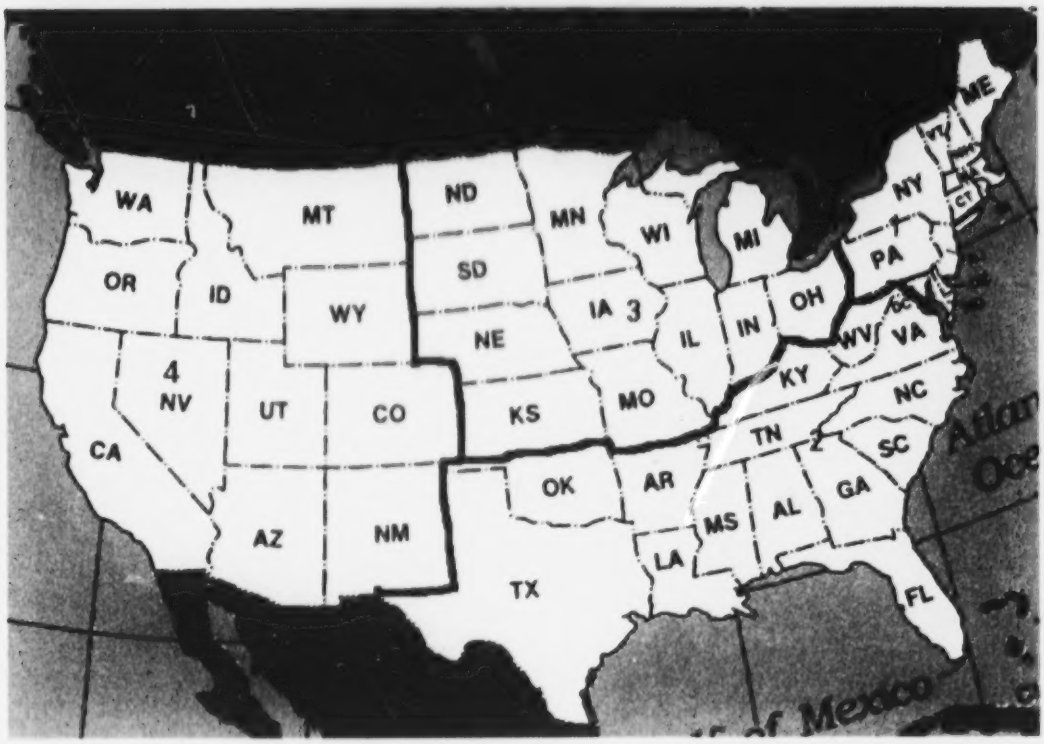
The point estimates of population sizes reported in Tables 1 and 2 were obtained from cell means arising in the analyses of variance described above. These means were weighted according to the proportions of subpopulation participants actually answering the corresponding questions and multiplied by the numbers in each subpopulation. Effectively, this approach (conservatively) classified nonresponses as zeros without distorting the corresponding standard deviations. The variances from the various cells were weighted according to the squares of the population proportions they represented in order to obtain estimates of total population variances, and, hence, standard deviations, which were then used to compute standard errors of the means and confidence intervals. The 90 percent confidence intervals for the total population estimates (IT and non–IT) ranged from +/– 9 percent to +/– 15 percent with the exception of the estimate of the number of systems analyst vacancies, which was +/– 19 percent. For the IT and non–IT populations, the confidence intervals were moderately greater, ranging from +/– 13 percent to +/– 21 percent for IT companies and from +/– 17 percent to +/– 33 percent for non–IT companies.

Likert–scale responses to the questions reported in Tables 3, 4, 5, 6, and 7 were analyzed using chi–square tests with respect to size, IT status, and geographical region. Significant results ($p < .01$) are outlined in the body of the report.

# APPENDIX V

# REGIONS OF THE UNITED STATES

## REGIONS OF THE UNITED STATES




Region 1: Northeast
Region 2: South
Region 3: Midwest
Region 4: West*

*Alaska and Hawaii were not included in the survey.

# APPENDIX VI

# SURVEY INSTRUMENT

## CALL RECORD

| I'WER DATE | TIME | RESULT INITIALS | CALL BACK CODE | DATE & TIME | COMMENTS |
|---|---|---|---|---|---|
| | | | | | |

01=No Answer
02=Busy Signal
03=Answering Machine
04=Call Back
05=Language Problem
06=Hearing Problem
07=Unreachable During Survey
09=Soft Refusal
10=Hard Refusal
11=Soft Refusal
12=Hard Refusal
13=Soft Refusal
14=Hard Refusal
15=Untraceable
16=Disconnected Number
17=Temporarily Out of Order
18=Computer/Fax Tone
40=Complete

NAME:
PHONE:
COMPANY:

May I speak with [Contact Name]?

**INTERVIEWER:** If the contact person is not available, ask to speak with the Director of Human Resources or the Director of Personnel.

Hello, my name is _____ and I'm calling from Virginia Tech in conjunction with the Information Technology Association of America. We are conducting a research study about the need for competent and skilled information technology employees nationwide.

**IF ASKED ABOUT ITAA:** "The Information Technology Association of America (ITAA) is a non–profit association representing over 11,000 member companies throughout the U.S. which are involved in information technology activities. We are not calling to sell anything or to ask technical information."

**IF ASKED ABOUT CONFIDENTIALITY OR HOW THE RESULTS WILL BE USED:** "Your opinions are very important to us and will be completely confidential. Your responses will not be linked with your name or your company in any way." "The results will be released in January at a conference in California and will inform national policy initiatives."

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**Q1.** First, what is the total number of employees you have in your entire company at all locations? Would you say 100 to 499, 500 to 999, or over 1000 employees?

LESS THAN 100 1
100– 499 2
500– 999 3
Over 1000 4
DK/RF 5

**Q2.** Information technology is also referred to as "IT", approximately how many "IT" employees does your company now have?

**INTERVIEWER:** If given a range, enter the numeric range. If given a single discrete number, enter that same number twice. If response is "don't know" or if the respondent refuses, enter –1.

**IF ASKED FOR DEFINITION OF INFORMATION TECHNOLOGY:** "Information technology, also referred to as "IT", is defined as the study, design, development, implementation, or support and management of computer–based information systems, particularly software applications and computer hardware."

[IF RANGE OF NUMBERS>0 THEN GO TO Q3]

**Q2a.** Information technology employees are any employees who use computer–based information systems in any way. Does your company have any employees of this type?

YES 1
[ GO TO END 1] NO 2
[GO TO END 1] DK/NA/RF 3

**END 1:** I'm sorry we are only studying companies who currently have employees in IT. positions. Thank you very much for your time.

**Q2b.** How many employees of this type does your company currently employ?

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**Q3.** Approximately, how many vacancies would you estimate that your company currently has for employees skilled in information technology?

**Q4.** Approximately, how many IT employees would you say your company plans to hire over the next five years?

**Q5.** Now I have a series of statements about your company's information technology training needs. Please respond to each statement with either strongly agree, somewhat agree, somewhat disagree, or strongly disagree.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Q5a.** | First, constantly changing technology hinders your company in providing timely training. Do you... | strongly agree | somewhat agree | somewhat disagree or | strongly disagree? | DK/NA/RF |
| **Q5b.** | Employees leaving after your company has provided IT training is a problem. | STRONGLY AGREE | SOMEWHAT AGREE | SOMEWHAT DISAGREE | STRONGLY DISAGREE | DK/NA/RF |
| **Q5c.** | Your company budget does not meet your employee information technology training needs. | STRONGLY AGREE | SOMEWHAT AGREE | SOMEWHAT DISAGREE | STRONGLY DISAGREE | DK/NA/RF |
| **Q5d.** | Finding qualified IT training providers is difficult. | STRONGLY AGREE | SOMEWHAT AGREE | SOMEWHAT DISAGREE | STRONGLY DISAGREE | DK/NA/RF |

**Q6.** Now I want to ask you a few questions about your sources for IT training. Please respond to these questions with often, sometimes, rarely, or never.

**IF ASKED: "For this question we are referring to training for individuals already employed by your organization."**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Q6a.** | First, how often does your company rely on your own company training department for IT employee training? Would you say... | often | sometimes | rarely or | never? | DK/NA/RF |
| **Q6b.** | How often does your company rely on four-year colleges or universities for the training of IT employees? | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |
| **Q6c.** | On community or two-year technical colleges? | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |
| **Q6d.** | On hardware or software vendors? | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |
| **Q6e.** | Private IT training companies? | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |

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**Q7.** I am going to read a few possible solutions your company may use to respond to new or growing needs for employees in specific IT areas. For each, please indicate whether you think the best answer would be often, sometimes, rarely, or never.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Q7a.** | First, outsourcing information technology work to non–U.S. contractors who perform work for your company outside the United States. Would you say... | often | sometimes | rarely or | never? | DK/NA/RF |
| **Q7b.** | Using consultants or temporary employees to perform your company's information technology work. | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |
| **Q7c.** | Retraining existing company staff to meet information technology work needs. | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |
| **Q7d.** | Hiring new immigrants to the United States to respond to new or growing IT needs. | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |
| **Q7e.** | Hiring new employees to respond to new growth in specific IT areas. | OFTEN | SOMETIMES | RARELY | NEVER | DK/NA/RF |

**Q8.** Now I'm going to ask you about three specific IT occupation categories. They are Programmers, Systems Analysts and Computer Scientists or Engineers. The first category is Programmers. Examples might include Software Developers, Database Programmers, Programmer Analysts, and Web Developers.

**Q8a.** Do you employ Programmers in any area of your company?

YES 1
[GO TO Q9] NO 2
[GO TO Q9] DK/NA/RF 3

**Q8b.** Approximately how many Programmer positions do you have in your entire company?

**Q8c.** About how many Programmer vacancies would you say your company currently has?

**Q8d.** Approximately how many of the Programmer positions in your company require at least a bachelor's degree? Would you say all, most, some, or none?

[GO TO 8f] ALL 1
MOST 2
SOME 3
NONE 4
DK/NA/RF 5


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**Q8e.** About how many of the Programmer positions in your company require no more than a two–year degree or completion of a specialized certification program? Would you say all, most, some, or none?

ALL 1
MOST 2
SOME 3
NONE 4
DK/NA/RF 5

**Q8f.** How difficult is it for your company to hire qualified Programmers? Would you say very difficult, somewhat difficult, or not at all difficult?

VERY DIFFICULT 1
SOMEWHAT DIFFICULT 2
NOT AT ALL DIFFICULT 3
DK/NA/RF 4

**Q8g.** How difficult is it for your company to retain qualified Programmers?

VERY DIFFICULT 1
SOMEWHAT DIFFICULT 2
NOT AT ALL DIFFICULT 3
DK/NA/RF 4

**Q9.** The job title I'm going to ask you about now is Systems Analyst. Systems Analysts use their skills in a problem–solving capacity. Examples might include Systems Integrators or Network Administrators.

**Q9a.** Do you employ Systems Analysts in <u>any</u> area of your company?

YES 1
[GO TO Q10] NO 2
[GO TO Q10] DK/NA/RF 3

**Q9b.** Approximately how many Systems Analyst positions do you have in your entire company?

**Q9c.** About how many Systems Analyst vacancies would you say your company currently has?

**Q9d.** Approximately how many of the Systems Analyst positions in your company require at least a bachelor's degree? Would you say all, most, some, or none?

[GO TO Q9f] ALL 1
MOST 2
SOME 3
NONE 4
DK/NA/RF 5


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**Q9e.** About how many of the Systems Analyst positions in your company require no more than a two year degree or completion of a specialized certification program? Would you say all, most, some, or none?

ALL 1
MOST 2
SOME 3
NONE 4
DK/NA/RF 5

**Q9f.** How difficult is it for your company to hire qualified Systems Analysts? Would you say very difficult, somewhat difficult, or not at all difficult?

VERY DIFFICULT 1
SOMEWHAT DIFFICULT 2
NOT AT ALL DIFFICULT 3
DK/NA/RF 4

**Q9g.** How difficult is it for your company to retain qualified Systems Analysts?

VERY DIFFICULT 1
SOMEWHAT DIFFICULT 2
NOT AT ALL DIFFICULT 3
DK/NA/RF 4

**Q10.** The final job title I'm going to ask you about is Computer Scientist or Computer Engineer. Computer Scientists design and conduct research to improve computer design or use. Computer Engineers work with the hardware and software aspects of systems design and development.

**Q10a.** Do you employ Computer Scientists or Computer Engineers in <u>any</u> area of your company?

YES 1
[GO TO Q11] NO 2
[GO TO Q11] DK/NA/RF 3

**Q10b.** Approximately how many Computer Scientist or Computer Engineer positions do you have in your entire company?

**Q10c.** About how many Computer Scientist or Computer Engineer vacancies would you say your company currently has?


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**Q10d.** Approximately how many of the Computer Scientist or Computer Engineer positions in your company require at least a bachelor's degree? Would you say all, most, some, or none?

[GO TO Q10f] ALL 1
MOST 2
SOME 3
NONE 4
DK/NA/RF 5

**Q10e.** About how many of the Computer Scientist or Computer Engineer positions in your company require no more than a two year degree or completion of a specialized certification program? Would you say all, most, some or none?

ALL 1
MOST 2
SOME 3
NONE 4
DK/NA/RF 5

**Q10f.** How difficult is it for your company to hire qualified Computer Scientists or Computer Engineers? Would you say very difficult, somewhat difficult, or not at all difficult?

VERY DIFFICULT 1
SOMEWHAT DIFFICULT 2
NOT AT ALL DIFFICULT 3
DK/NA/RF 4

**Q10g.** How difficult is it for your company to retain qualified Computer Scientists or Computer Engineers?

VERY DIFFICULT 1
SOMEWHAT DIFFICULT 2
NOT AT ALL DIFFICULT 3
DK/NA/RF 4

**Q11.** Does your company have any other categories of professional IT workers we have not already mentioned?

YES 1
[GO TO Q12] NO 2
DK/NA/RF 3

**IF ASKED:** Information technology, also referred to as "IT", is defined as the study, design, development, implementation, or support and management of computer–based information systems, particularly software applications and computer hardware.

**Q11a.** What is one of the other categories?

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**Q11b.** How many [response from Q11a] would you say your company employs?

**Q11c.** Any other categories?

[GO TO Q11a] YES 1
NO 2
DK/NA/RF 3

**Q12.** Finally, may I please have your official company job title?

[Please specify:_____]YES 1
NO/DK/NA/RF 2

**Those are all of our questions. Thank you for your help with our study.**

**IF ASKED:** For more information on this survey, you may contact Mark Schaefermeyer at 540–231–3259 or Jyl Smithson at 540–231–3144.

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# APPENDIX VII

# RESEARCH TEAM

## VIRGINIA POLYTECHNIC INSTITUTE AND UNIVERSITY

## RESEARCH TEAM

Dr. Linda G. Leffel, Professor, Director of Program Development, Division of Continuing Education, and Project Director

Dr. Robert B. Frary, Professor Emeritus, Measurement and Testing Research, Research and Statistical Consultant

Ms. Shanan Gwaltney, Research Associate, Division of Continuing Education

Dr. Mark J. Schaefermeyer, Assistant Director of Program Development, Division of Continuing Education

Ms. Jyl Smithson-Riehl, Assistant Director of Program Development, Division of Continuing Education

Dr. Alan E. Bayer, Director, Center for Survey Research

Mr. Michael B. Clark, Data Systems Manager, Center for Survey Research

Ms. Susan M. Willis, Projects Manager, Center for Survey Research

# APPENDIX VIII

# IT CONVOCATION TASK FORCE SUMMARIES

## 1998 National Information Technology Workforce Convocation Task Force Descriptions, Findings, and Members

Provided below are summaries of the results of the six task forces convened for the 1998 National Information Technology Workforce Convocation: Basic Math and Science Competencies, Image of the IT Profession, Quality and Productivity Issues, Recruiting of Underrepresented Groups, Responsiveness of Industry and Higher Education to Each Other's Needs, and Skill Upgrading of the Current Workforce. These summaries were prepared by Lauren Brownstein, Workforce Education Program Manager, ITAA. For the complete task force results, please visit http://www.techworkforce.org.

### Task Force: Basic Math and Science Competencies

The Task Force for Basic Math and Science Competencies aims at increasing interest and competency in math and science so that potential information technology (IT) workers possess the necessary skill sets. This task force recognizes several problems facing U.S. students. These students are not performing math at proficient levels and will not possess the level of math competencies needed to participate successfully in the rapidly changing IT job market. There may be too few students exiting American secondary education that have the requisite skills and aptitudes to fill the immense IT workforce shortage.

In light of this, the task force has suggested the following actions:

- Teachers must be required to have earned at least a bachelor's degree in mathematics or science to qualify as a math and/or science teacher.
- Schools of Education must change their credentialing process to better prepare teachers for the classroom.
- Increased salaries for qualified math/science instructors should be considered.
- Professional development for math/science teachers in the workforce will increase classroom efficacy.
- Rigorous curriculum standards must be insisted upon.
- Project–based learning approaches, linked to application in business or industry, are necessary.
- Corporate and business donations should be carefully targeted to meet needs.

### Task Force: Image of the IT Professions

Among all age groups, people generally have a distorted and often negative image of IT professions. Children and adults may embrace a negative image of IT professionals as a result of their constant exposure to unflattering media images of the profession and limited exposure to, and knowledge of, real–life IT professionals. Furthermore, as students progress in school, the involvement with IT becomes a mostly male preserve. Many adults fear new technology because of potential job displacement and a sense that preparing for those jobs requires difficult to acquire knowledge and skills. The Image of the IT Professions Task Force is working to find ways to alleviate these misconceptions by emphasizing efforts to shift the popular perception of IT jobs so they reflect the dynamic, exciting opportunities that the field offers. The task force has identified an number of solutions to the image problem.

The task force recommends a nation–wide, industry–led campaign based on a partnership among industry, labor, education, and government that would include four basic themes:

- "Technology is cool, it's the future, it's exciting."
- IT professions are mainstream.
- IT professions are lucrative and stimulating.
- IT professionals are not all geniuses, engineers, or scientists with degrees.
- The task force also suggests that a publicity campaign be generated that incorporates the education community, employers, unions, media, government, and parents. This multimedia campaign should be national in scope.

### Task Force: Quality and Productivity Issues

The Task Force for Quality and Productivity Issues concentrates on efforts to maintain a high–quality, cost–efficient IT workforce. The global competitiveness of U.S. software development is weakening in terms of the productivity and cost structure of its software engineering workforce. There is a need for new economic indicators relating to IT and the development of an educational/training infrastructure that allows the United States to produce world–class software engineers.

The Quality and Productivity Task Force suggests that at the national level, the United States should consider policies that

- Establish a national priority to "pull" driving software quality up. A best practices approach should be adopted, and underlying factors that effect U.S. software competitiveness should be identified.
- Provide national industry with "relativity tools" through the Department of Commerce.
- Encourage start–ups to attract outside investment.
- Develop new skills and competencies in the existing workforce; lay the foundation for the next generation's high–performance workforce.

The task force believes that

- Educational opportunities should be expanded. Educational alliances and cross discipline training/retraining should be expanded.
- Community colleges are perceived to be better suited to meeting industry skills needs than are four–year colleges.
- Retraining of mature adults (women reentering the workforce) and downsized engineers from other fields (civil and mechanical engineers) who desire to enter the IT programmer/software engineering field has promise.
- Technical curricula need to be developed by specialists who understand the industry needs.
- An aggressive program of benchmarking performance calibration and performance management should be maintained.

**Task Force: Recruiting of Underrepresented Groups**

The Task Force Recruiting of Underrepresented Groups aims to expand the pool of potential workers in the IT field to include more women, minorities, vocational students, and other nontraditional IT workers. Currently, women, minorities, people with disabilities, and mid–career and older technical professionals are underrepresented and underutilized groups in technical fields. At the same time, employers are experiencing difficulties in fulfilling their needs for highly skilled IT workers.

The Task Force on Recruiting of Underrepresented Groups has suggested that the following actions be taken:

- Teachers and guidance counselors should be provided with better information and training to help them guide underrepresented groups into the IT education and career pipeline.

- Math and science programs should be designed to accommodate the learning styles of girls and minorities and to make these subjects more relevant to their lives.
- Women and minority groups would benefit from having of IT mentors and role models from which to draw inspiration and guidance.
- The establishment of "learning communities" of women peers in educational environments may help women overcome barriers to learning and working in male dominated technical fields.
- Companies could explore recruiting options through minority technical and professional societies.
- Companies could place job ads in newspapers and journals that serve racial and ethnic minority communities.
- Companies should be encouraged to establish partnerships with and recruit from historically black colleges and universities, predominantly Hispanic colleges and universities, and Native American junior and community colleges based on Indian reservations.
- Companies could form partnerships with racial and ethnic minority student societies at colleges and universities.
- Ensure underrepresented groups have access to adequate information about the IT labor market, the skills needed, and potential employers.
- Models that are working to recruit these groups should be shared and disseminated.

**Task Force: Responsiveness of Industry and Higher Education to Each Other's Needs**

The Task Force for Responsiveness of Industry and Higher Education to Each Other's Needs strives to facilitate the exchange of information and resources so that properly skilled workers enter the marketplace. Recently, the number of students in American higher education that attained a bachelor's degree in computer sciences fell drastically. Students entering higher education are choosing fields of study that are not necessarily lucrative or in demand. These issues indicate a disconnect between industry, education, and the academic and professional aspirations of young Americans.

The following suggestions have been compiled by the task force in an effort to address these current issues.

Industry Initiatives – Funding and support:

- Money to fund IT training should also go to two–year, as well as four–year institutions.

- At the community–college and private training level, industry should continue to form partnerships to address industry–specific and regional training needs.
- The business community should articulate broader industry needs more effectively.
- Proprietary product information should be disseminated to institutions of higher education while still protecting intellectual property rights.
- Businesses can help colleges and universities to stay current by investing in higher education's existing technology and by providing relevant training to teaching staff.

Higher Education Initiatives – Goals for higher education:

- Revise curricula more quickly.
- Provide flexible delivery methods.
- Encourage collaboration among higher education sectors.
- Increase opportunities for local and national industry input.
- Shift attitudes and perceptions about workforce responsiveness.

Industry and higher Education working together – Areas of cooperation:

- Develop outreach to high school students.
- Look at curriculum in general and determine how to bring the needs of the workforce and colleges into closer alignment.
- Capitalize on the national attention of the IT Workforce Convocation.
- Develop multi–year programs such as faculty/IT worker exchanges and curriculum advisory boards.

**Task Force: Skill Upgrading of the Current Workforce**

The Task Force for Skill Upgrading of the Current Workforce aspires to enhance the skills of current workers so that they do not become obsolete. At present, workers are not adequately aware of the advantages of working in this new, volatile, complex industry. They may also be unaware of how to join it. The industry is moving from one specific technology to another faster than it is building the skills to support these moves. Meanwhile, some educators have just begun to be aggressive in helping companies and workers to build skills. They are often not in a position to manage the rapid change or the expense of the technology currency that is required if they are to be fully effective in this arena.

The task force has concluded that the IT industry should consider the following mechanisms:

- Develop an awareness campaign to be aimed at employers, IT companies, unions, education providers and unions. Messages should reach children and their parents early in the child's life.
- Establish intensive training programs like the ODU COBOL "boot camp" or the MSC Fellowship, which train workers (usually not current IT workers) to program or provide some other IT service.
- Establish certification programs that certify skills and that have broad acceptance in the economy.
- Implement new technology to reduce internal IT support requirements.
- Develop strategies for in–house IT training/promotion that would move current employees into IT positions and upgrade the skill and job scope of current IT workers.
- Augment training staff with private trainers or staff from technology–capable higher education institutions.
- Develop more technology–driven education solutions.
- Establish continuous processes for skill building, job changing, and system renewal.
- Balance the cost of upscaling against the value to the economy, to the employer, and to the worker.
- Document career paths and provide that documentation to workers, along with job market information.
- Define a way to distinguish meaningful skills from "fad" skills to ensure proper use of resources in skill building.
- Develop a road map of skills the workforce will need in the future as the industry develops.
- Reexamine hiring practices.

## Task Force Members

### Basic Math and Science Competencies

Chairperson, Dr. Shoumen Datta, President, Associated Scientists

Lila Adair, K–12 Teacher
Rob Adams, K–12 Teacher
George Amann, K–12 Teacher
Karen Bouffard, K–12 Teacher
Jack DePalma, K–12 Teacher
James Dyke, Former Virginia Secretary of Education

Dennis Frezzo, K–12 Teacher
David Goslin, American Institutes for Research
Roger Harris, K–12 Teacher
Floyd Holt, K–12 Teacher
Emily James, K–12 Teacher
Michael Lach, K–12 Teacher
Jenica Lee, Student
Cherie B. Lehman, Presidential Award for Excellence in Science Teaching
Nancy Lewis, Microsoft Corporation
Aida Metzenberg, CSU Northridge
Stan Metzenberg, CSU Northridge
Alexandra Montes, K–12 Teacher
Stephen A. Patay, TRW Technology & Strategic Planning
Rose Payapilli, Student
Alice Pritikin, Student
Harry Rheam, K–12 Teacher
Debbie Rice, K–12 Teacher
Glenn T. Seaborg, Lawrence Berkeley Laboratory
Robert Shaner, K–12 Teacher
Alexandra Smith, Student
Albert Thompson, K–12 Teacher
Charles H. Townes, UC Berkeley
Felicia Voss, Student
Kevin Warner, Cisco Systems
Robin Willner, IBM

**Image of the IT Professions**

Chairperson, Paul F. Cole, Secretary–Treasurer, New York State AFL–CIO
Vice President, American Federation of Teachers

Paul Anderson, Communications Workers of America
Gary Beach, International Data Group
Robert Carillo, S. Orangetown Middle School District
Bill Castanier, Michigan Jobs Commission
Ellen Derwin, DeVry Inc.
Gerard H. Gaynor, G.H. Gaynor & Associates
Jan Grecian, Office of Information Technology, State of Missouri
Dr. Donald E. Kirk, San Jose State University, College of Engineering
Ben Kittner, TechKnowledge Communications Inc.
Jon Korin, Litton/PRC Inc.
Gail K. Lutey, Complete Business Solutions, Inc.
Barbara Mitchell, AT&T
Delana Rauterkus, US West Information Technologies
Charles Stunson, American Federation of Teachers

Clif Webb, Ryan–McGinn
Rick Weingarten, Computer Research Association
Mary K. Wolf, U.S. Department of Commerce

**Quality and Productivity Issues**

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Dr. Barry Boehm, University of Southern California
Dr. Jerry Grochow, American Management Systems
Capers Jones, Software Productivity Research
Frank McGrath, Department of Defense
Mike Meyer, Cap Gemini
Larry Putnam, Quantitative Software Management
E.P. Rogers, MONY
Steven Sheinheit, Chase
Michael Sinneck, IBM Global Services
Wolfgang Strigel, Software Productivity Consortium (Canada)
Charles Symons, Symons Consulting (UK)
Ed Yourdon, Nodruoy Inc.

**Recruiting of Underrepresented Groups**

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Dorothy Bennett, Education Development Center
Anita Brown, Black Geeks Online
Dr. Jaleh Daie, Association for Women in Science
Carla Dancy, EDS
Jim Dyke, McGuire, Woods, Battle, & Boothe
H. Martin Haley, Potomac Knowledgeway
Mark Kadesh, Collis Warner Foundation
Dr. Gideon Kantor, American Engineering Association
Brett Lovejoy, American Vocational Association
Carol Ann Mears, US Department of Commerce
Archie Prioleau, Washington Technology Initiative
Bob Rivers, American Engineering Association
Jim Van Erden, National Alliance of Business
Carol Walcoff, Walcoff & Associates
Gwen Weaver, American Council on Education
Sylvia Wilson Thomas, Howard University

## Responsiveness of Industry and Higher Education to Each Other's Needs

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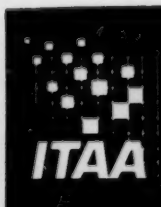
Norma Abe, Hewlett–Packard Corporation
Clifford Adelman, U.S. Department of Education
Nokware Adesegun, Bowie State University
Avron Barr, Stanford Computer Industry Project
John Barth, National Governor's Association
Doug Bowman, Lockheed Martin Corporation
Ida Brandon, Bowie State University
Robert Cannon, University of South Carolina
Phillip Cartwright, Change Magazine
Brian Darmody, University of Maryland, College Park
Richard Detweiler, Hartwick College
Mark Dreyfuss, ECPI College of Technology
Neil Evans, NorthWest Center for Emerging Technologies
Sister Eymard Gallagher, Marymount University
Karen Goodwin, Trinity College
Richard Gowdy, American Legislative Exchange Council
Jimmie Haines, University of Nebraska at Omaha
Kay K. Haverkamp, Northern Virginia Community College
Tom Howell, National Science Foundation
Annie Hunt-Burris, University System of Georgia
Joel Iskowitz, Troy Systems, Inc.
Doug Johnson, Hewlett Packard Corporation
Christopher Jones, Microsoft Corporation
Hon. Martha Klima, Maryland House of Delegates, American Legislative Exchange Council
James D. Lafond, Coopers and Lybrand, LLP
Linda G. Leffel, Virginia Tech
James Lightbourne, National Science Foundation
Jeffrey Livingston, Western Governors University
James D. Mayo, The Catholic University of America
Mark Milliron, The League for Innovation in Community Colleges
Al Moye, Hewlett Packard Corporation
Rick Paddock, U.S. Department of Commerce
John Pendray, George Mason University
Nathanael Pollard, Bowie State University
Irwin Price, George Washington University
Lorie Prouty, DeAnza College
Joseph Rodota, Office of Governor Pete Wilson
Todd Rowley, First Union National Bank
Donald Sargeant, University of Minnesota
Susan Sauer, National Science Foundation

Mark Schaefermeyer, Virginia Tech
Jim Schmidt, First National Bank of Omaha
Jyl Smithson–Riehl, Virginia Tech
Robert Sweeney, Applied Information Management Institute
Marga Torrence, Troy Systems, Inc.
Patrick Valentine, Colleges and Corporations, LLC
Suzanne Wheeler, Indiana Business Modernization and Technology Corporation
Roger Whitaker, George Washington University

**Skill Upgrading of the Current Workforce**

Chairperson, Sean Rush, General Manager, Global Education Industry, IBM

Ken Edwards, IBEW
Dr. David Gulley, Chicago Manufacturing Center
Steve Hoffman, Sylvan Learning
Dr. Steve Johnson, St. Peters Jr. College
Debra Kolodny, Consultant, Labor/Management
Paul Kostek, IEEE
Linda G. Leffel, Virginia Tech
May McCain, ASTD
Don McLaurin, Computer Consulting Group
Joyce Plotkin, Massachusetts Software Council
Gary Reed, Office of the Asst. Secretary for Policy
Mark Schaefermeyer, Virginia Tech
Donald Treinen, AFL–CIO, Alliance Plus
Diane Tunick, Gartner Group
Kathy Walsh, IBM

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